Final Technical Report

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Title of the Award: **Using Earthquake Scenario Products in the Pacific Northwest to Develop an Online Earthquake Scenario Repository through the FEMA GeoPlatform (or "The Pacific Northwest Scenario Archive Project")**

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Abstract
With funding from the U.S. Geological Survey, the Earthquake Engineering Research Institute (EERI) led a committee comprised of federal and state agencies to produce a public *Pacific Northwest Archive Scenario Archive* website that serves as a repository for data maps visualizing region-specific earthquake scenario hazard data (from USGS ShakeMaps) and loss data (produced using Hazus) on the Federal Emergency Management Agency (FEMA) GeoPlatform. This initial archive represents scenarios in the Pacific Northwest Region, and is a pilot for future scenarios for which the FEMA GeoPlatform may be expanded for use nationwide. This Project aims to provide a replicable process for making Hazus scenarios available across sectors and includes a step-by-step publication guide in addition to a guide for users to interpret the scenarios posted by publishers.

Report
The *Pacific Northwest Archive Scenario Archive Project* supports Hazus scenario information sharing and interpretability across sectors. It also enhances the value and utilization of existing USGS-produced regional scenario ShakeMaps by using these hazard data as a starting point for Hazus risk assessments and loss estimates. The Project resources the industry standard tool for earthquake risk analysis (Hazus) and describes a process for converting Hazus scenario outputs to ArcGIS Online compatible data for use with the FEMA GeoPlatform.

The final product of this project was a new public *Pacific Northwest Archive Scenario Archive* website that serves as a repository for data maps visualizing region-specific earthquake scenario hazard data (from USGS ShakeMaps) and loss data (produced using Hazus) on the FEMA GeoPlatform. Along with this new interactive online resource showcasing data maps for various regional scenarios, two instructional guidance documents were also produced to support the publication of new scenarios by future scenario producers and to support interpretation and use of the data by interested stakeholders.

The Project and accompanying research was subject to committee oversight and was divided into four phases: (1) Establish Committee: project oversight and collaboration; (2) Define Scope: Audience (Publisher and User) identification and scenario definition; (3) Produce Documentation: Research and authorship of guidance documents for using the Archive; and (4) Launch Archive: establishing the Pacific Northwest Scenario Archive on the GeoPlatform with three completed scenario examples. More details on each project phase is described below.

While theses initial activities were completed in 2017, it is hoped that this website and associated guidance documents become living resources that can be modified and used overtime by stakeholders. Because this project has provided a replicable process for making Hazus scenarios available across sectors using the FEMA GeoPlatform, this new Pacific-Northwest-focused archive could become a pilot for future scenarios nationwide.

1. Establish Committee
A Pacific Northwest Scenario Archive Committee was established at the start of the project. It was composed of members from the following agencies: United States Geological Survey (USGS), Earthquake Engineering Research Institute (EERI), University of Washington (UW), Washington Emergency Management Division (WEMD), Oregon Department of Geology and Mineral Industries (DOGAMI), Cascadia Region Earthquake Working group (CREW), California Office of Emergency Services (CalOES), Washington Department of Natural Resources (Washington State DNR), the Oregon

Office of Emergency Management (Oregon OEM), and the Federal Emergency Management Agency (FEMA).

Through frequent collaboration among these members, a need for an archive of scenarios that are useful to state, local, and federal stakeholders was identified. From 2016-2017, Pacific Northwest Scenario Archive Committee members representing each of the above agencies worked to develop the scope and context for the scenario project using example templates from ESRI's ArcGIS Online platform. Select committee members also to served as expert reviewers for accompanying User and Publisher guidance documents through the various stages of Archive development.

2. Define Scope

Scenario stakeholders were identified as community members, the media, planners, policy-makers, engineers, and others interested in mitigating (or minimizing) damage from potential catastrophic earthquakes.

Because stakeholders might be unfamiliar with hazard scenario modeling in general, effort was made to identify and define scenario types as appropriate for the context of this project. We identified two kinds of scenarios and clarified these to avoid user confusion, and explained in some detail any necessary background information to support understanding.

Technical Scenario

Often scientists consider a "scenario" a hazard or loss model, such as a scenario ShakeMap (shaking hazard) or a technical scenario Hazus run (impact), that could be used by stakeholders or for planning exercises. These technical scenarios are limited to a model using a software program designed for the task (e.g., ShakeMap, Hazus, PAGER, etc.).

Scenario Exercise

A "scenario exercise" refers to a broader term that requires collaboration from federal, state, regional, and local officials; a committee comprised of engineers, planners, economists, and technical people organize around a specific potential hazard and produce a model. An example of this is California's Haywired Scenario -- a project led by the USGS that informs mitigation strategies for a Magnitude 7.05 San Francisco Bay Area earthquake along the region's Hayward Fault.

The Archive was designed to be a platform for publishing and viewing hazard or loss models based on the former definition of technical scenario model (not the scenario exercise model).

3. Produce Documentation

With the help of a dedicated research and editing team and the PNW Archive Scenario Committee, two main *Pacific Northwest Scenario Archive* guidance documents were developed for two distinct user groups: (1) A step-by-step publication guide for earthquake scenario developers **(Publishers)** who wish to use the FEMA GeoPlatform to disseminate completed earthquake scenarios for public stakeholders **(Users)**, who are provided with (2) a separate, less technical document for interpreting and utilizing the Archive for planning purposes.

These guideline documents introduce the FEMA GeoPlatform for those unfamiliar with it, and:

- describe the kinds of scenarios that can be published on the GeoPlatform
- provide step-by-step publication guidance
- provide user interpretation guidance
- include other resources for visualizing earthquake scenario information.

The goal of these documents was to provide a guide for stakeholders who wish to view and analyze existing scenarios for the Pacific Northwest region that have been modeled and posted to the Pacific Northwest Scenario Archive. Documentation is exclusively focused on these 'technical scenario' models, although these models could be used as a foundation to develop a larger 'scenario exercise' project (like the aforementioned Haywired Scenario).

The project team members developed the initial drafts of these documents over many months. To obtain fresh input on the content of these guidance documents before final publication, five researchers were recruited and trained on the developing scenario archive process during a remote training workshop. In turn, these researchers provided feedback and expertise used to refine the project, uploaded sample scenario examples, and tested the instructions included in the documents before the final Archive was publically launched.

4. Launch Archive

The FEMA GeoPlatform is a web-based cartographic resource through which Publishers can publish geographic information to a web map that is viewable by public Users. Based on ESRI's proprietary platform (ArcGIS Online), the FEMA GeoPlatform looks and functions similarly to other GIS-based systems of visualizing geographic layers and spatial data online.

The FEMA GeoPlatform is an excellent way to disseminate information to users who do not have access to ESRI's ArcGIS products (e.g. ArcMap, ArcScene, ArcPro, ArcGIS Online). Many data visualization resources are cost prohibitive for smaller organizations and local agencies, and cartographic visualizations are often limited to users with the appropriate licensing for accessing and viewing information. In contrast, earthquake scenario results published on the FEMA GeoPlatform are viewable on any web browser and do not require authentication to do so. Further, the FEMA GeoPlatform was developed specifically for visualizing risk-based predictions of sustained damage by user-defined features of interest in the event of a natural hazard. Using a cartographic system of features, symbolization, and pop-ups, users can navigate earthquake scenario results and access associated attribute tables that contain statistical information on system performance and predicted damage information.

The data provided in the Hazus model results are presented in a format supported by FEMA, USGS, and state agencies. There is a lot of information available in the results of a Hazus run. Technical users (Publishers) running an earthquake model choose which elements of the outputs are most relevant to response, and the (User) guidelines provide a means for stakeholders to interpret these.

The scenario examples published to the Archive were converted to ArcGIS Online compatible format using a Python-based geoprocessing tool that converts Hazus outputs into data readily usable on the FEMA GeoPlatform.

At the time of its formal public launch, the Archive contained six example scenarios published to the FEMA GeoPlatform and can be contributed to and edited by Publishers who request access. Users can access the FEMA GeoPlatform to view scenarios by visiting the *Pacific Northwest Scenario Archive Project* public interface. While the project only expected to produce three example scenarios in this phase, recruitment and support from additional researchers resulted in the final archive product containing a total of six comprehensive scenario examples. The USGS ShakeMaps used in these examples were selected from the USGS ShakeMap site and used by the research team to complete a Hazus analysis for each ShakeMap. The Hazus results were converted with the Python tool for visualization on the FEMA GeoPlatform data maps in *Pacific Northwest Scenario Archive*.

GO TO THE PACIFIC NORTHWEST SCENARIO ARCHIVE: http://arcg.is/2pm2fC8

Bibliography

1. Archive http://arcg.is/2pm2fC8
2. User Guide https://www.eeri.org/pnw_users-document/
3. Publisher Guide https://www.eeri.org/pnw_publishers-document/